

DISCUSSION OUTLINE

August 7, 2002

Prepared by:
Ricondo & Associates, Inc.

AGENDA

- I. INTRODUCTION**
- II. CAPACITY ESTIMATES**
- III. AIRCRAFT OPERATIONAL LEVELS**
- IV. CAPACITY/DEMAND RELATIONSHIP**

APPENDIX

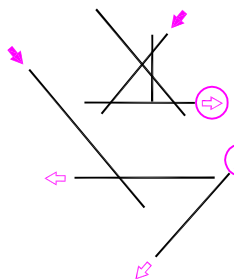
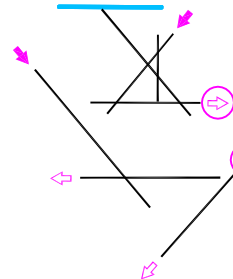
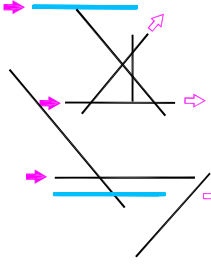
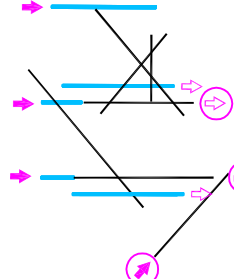
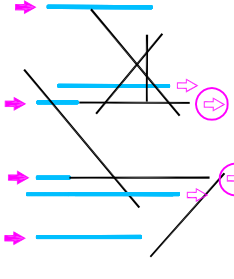
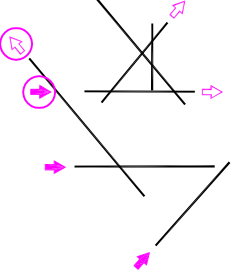
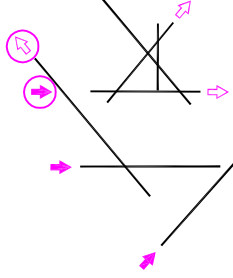
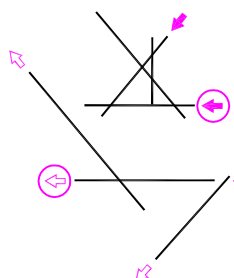
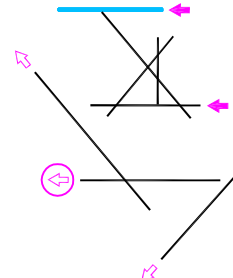
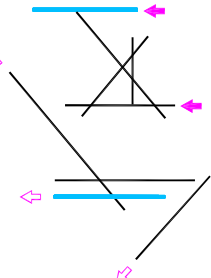
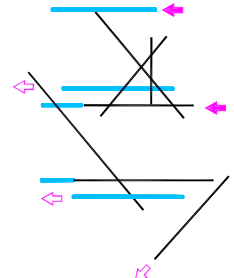
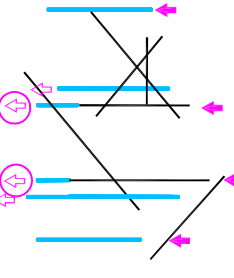
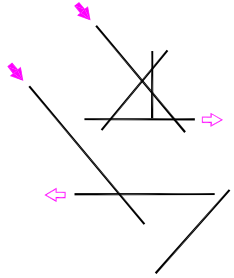
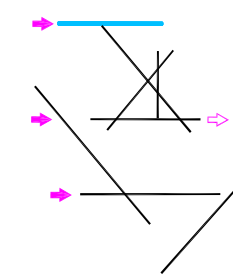
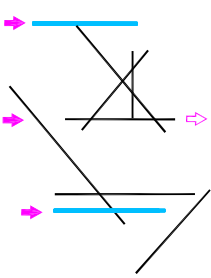
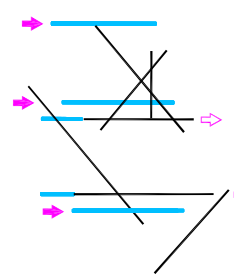
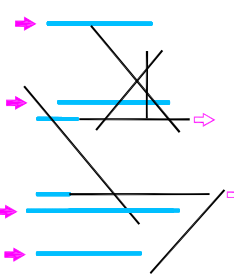
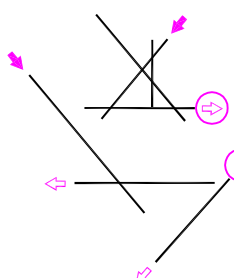
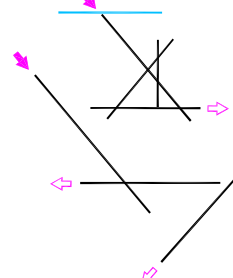
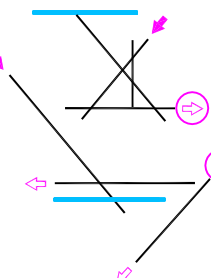
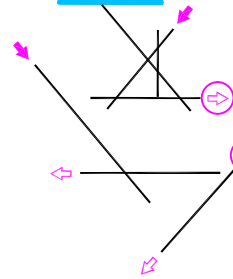
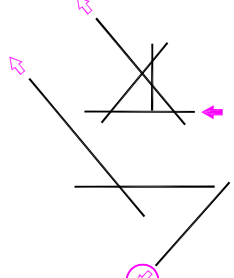
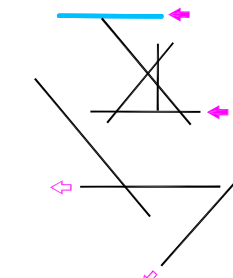
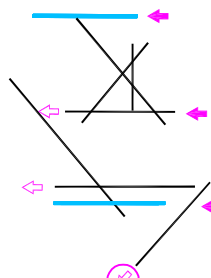
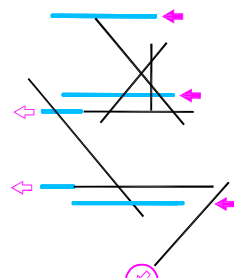
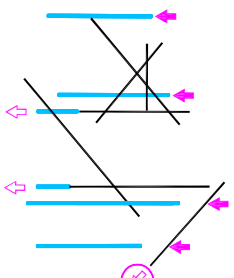
I. INTRODUCTION

1. This document outlines the aircraft operational merits of two possible options for the initial phase of development for runway components of the O'Hare Modernization Program. One option involves development of the independent north 9/27 runway as the initial phase of development. The second option involves development of the independent north 9/27 runway and the closely-spaced dependent south 9/27 runway comprising the initial phase of development. These options may also include the extension of Runways 14L and 9R and the shortening of Runways 32R and 32L.
2. The information presented here is intended exclusively to provide a relative assessment of the merits of these two options. Capacity estimates for each option have been derived from analytical methodologies developed by the FAA and used as part of the FAA's Capacity and Delay Model as well as those used by the FAA Air Traffic Control Tower to estimate runway acceptance rates. Capacity estimates developed previously by R&A for the runway system proposed by the City of Chicago for O'Hare International Airport have been updated using these methodologies. In addition, input received from airlines and air traffic controllers since the City unveiled the proposed runway reconfiguration concept for the Airport relative to operational plans for various runway options have also been incorporated. It is important to recognize, however, that the capacity estimates presented here are not intended to replace throughput, delay, and other operational information to be developed as part of the computer simulation analyses and other studies currently underway.
3. The following sections review the current aircraft operational levels at O'Hare, existing and projected runway operating configurations under alternate airfield layouts, estimated runway capacities under various operating configurations for the alternate airfield layouts, and relationships between demand distributions and estimated runway capacities. General assessments of operational delays at increasing demand levels are also discussed.

II. CAPACITY ESTIMATES

1. Simulation analyses and other studies currently underway as part of the O'Hare Modernization Program (OMP) efforts will produce a thorough assessment of the operational performance of the proposed airfield layout and its development phases. The information discussed here, however, is much more narrowly defined and intended only to assist in providing an indication of the merits of two initial development options. It must be understood that the capacity and delay estimates presented here are, by their nature, gross approximations of runway capacities and may not reflect the impact of airspace, airfield (taxiway and other airfield geometry issues), fleet, human, and other factors that influence airfield performance. In general, these should be viewed in relative terms (i.e., use only for comparisons between alternatives rather than for absolute judgments).
2. The two phasing options considered here involve development of the north independent runway or development of that runway in conjunction with the closely-spaced south runway. For purposes of this discussion, it is assumed that the extension of Runways 14L and 9L and the shortening of Runways 32R and 32L can occur with either option.
3. **Exhibit 1** illustrates the operating configurations anticipated to be used with each runway layout. For comparison purposes, the existing runway operating configurations and those anticipated for a runway layout consisting of five or six east/west runways are also included. The six east/west runway layout is representative of Option 5 currently being simulated while the four east/west runway layout is representative of Option 1 currently being simulated. Exhibit 1 also includes the hourly capacity estimate for each operating configuration computed using FAA Capacity and Delay Model techniques and assuming a balanced arrival/departure operation. These capacity estimates, and the resulting weighed average capacity estimate, are shown in tabular form in **Table 1**.
4. Table 1 also includes hourly capacity estimates based on methodologies used by the FAA's Air Traffic Control Tower to estimate runway capacity. Both sets of estimates are relatively similar, though certain differences are evident for some operating configurations. In general, this second set of estimates produces a wider difference in capacity estimates between the development alternatives.
5. While not clearly evident from the capacity estimates presented here, it is significant to note that IFR arrival capacity is significantly increased by the addition of the north independent runway, which provides the ability to maintain a third independent arrival stream during IFR. However, for the runway configurations that provide only for the north runway, arrival/departure

balance is provided by making mixed use of runways (using the same runway for arrivals/departures) or using runways that erode arrival capacity to provide departure capability, thus, overall capacity is not significantly enhanced in these cases.

EXISTING AIRFIELD		NORTH 9-27		NORTH 9-27 WITH SOUTH DEPENDENT PARALLEL		NORTH 9-27 WITH DEPENDENT PARALLELS		NORTH & SOUTH 9-27 WITH DEPENDENT PARALLELS
VFR East Operating Configurations								
								
Plan-B (VFR-2) - 25.5 % Balanced Arrivals/Departures = 187		Plan-B (VFR-2) - 25.5 % Balanced Arrivals/Departures = 187		VFR-East - 62.0 % Balanced Arrivals/Departures = 214		VFR-East - 62.0 % Balanced Arrivals/Departures = 273		VFR-East - 62.0 % Balanced Arrivals/Departures = 289
								
Plan-X (VFR-3) - 36.5 % Balanced Arrivals/Departures = 198		Plan-X (VFR-3) - 36.5 % Balanced Arrivals/Departures = 198						
VFR West Operating Configurations								
								
Plan-W (VFR-4) - 28.2 % Balanced Arrivals/Departures = 229		VFR-West - 28.2 % Balanced Arrivals/Departures = 229		VFR-West - 28.2 % Balanced Arrivals/Departures = 238		VFR-West - 28.2 % Balanced Arrivals/Departures = 238		VFR-West 28.2 % Balanced Arrivals/Departures = 292
IFR East Operating Configurations								
								
IFR-1 - 0.8 % CAT I/II/III Balanced Arrivals/Departures = 144		IFR-East 0.0 % CAT I/II/III Balanced Arrivals/Departures = 136		IFR-East - 0.8 % CAT I/II/III Balanced Arrivals/Departures = 152		IFR-East - 2.9 % CAT I/II/III Balanced Arrivals/Departures = 175		IFR-East - 2.9 % CAT I/II/III Balanced Arrivals/Departures = 194
								
Plan-B IFR - 2.1 % IFR - 700/2 to 1000/3 visibility Balanced Arrivals/Departures = 187		IFR-1 - 0.8 % CAT I/II/III Balanced Arrivals/Departures = 144		Plan-B IFR - 2.1 % IFR - 700/2 to 1000/3 visibility Balanced Arrivals/Departures = 187				
								
		Plan-B IFR - 2.1 % IFR - 700/2 to 1000/3 visibility Balanced Arrivals/Departures = 187						
IFR West Operating Configurations								
								
IFR-2 - 6.9 % CAT I/II/III Balanced Arrivals/Departures = 148		IFR-West - 6.9 % CAT I/II/III Balanced Arrivals/Departures = 172		IFR-West - 6.9 % CAT I/II/III Balanced Arrivals/Departures = 196		IFR-West - 6.9 % CAT I/II/III Balanced Arrivals/Departures = 222		IFR-West - 6.9 % CAT I/II/III Balanced Arrivals/Departures = 232





-  Aircraft arrival operations
-  Aircraft departure operations
-  Reduced rate aircraft arrival operations (increased in-trail separations); used during arrival priority operations
-  Reduced rate departure operations (operational dependency on one or more runways); used during departure priority operations

Table 1
Updated Preliminary Runway Capacity Summaries
Chicago O'Hare International Airport
July 2002

	Percent Use	BALANCED CAPACITY, OPERATIONS/HOUR (1)			BALANCED CAPACITY, OPERATIONS/HOUR (2)		
		Existing	North R/W	North & South C/S	Existing	North R/W	North & South C/S
VFR OPERATIONS							
- "East" Flow Configurations							
-- Plan "B"	25.5%	187	187		188	188	
-- Plan "X"	36.5%	198	198		203	203	
-- VFR-East	62.0%			214			220
- "West" Flow Configurations							
-- Plan "W"	28.2%	229			218		
-- VFR-West	28.2%		229	238		218	240
IFR OPERATIONS							
- IFR Plan B	2.1%	187	187	187	188	188	188
- "East" Flow Configurations	0.8%	144	144	152	145	145	154
			136(3)			138(3)	
- "West" Flow Configurations	6.9%	148	172	196	160	176	204
	100.00%						
WEIGHED AVERAGE CAPACITY		200	201	218	200	201	223

NOTES:
All capacity estimates are preliminary and based on analytical assessments of the airfield configurations as currently understood. These estimates do not reflect results of simulation analyses currently underway. Similarly, they focus on runway operations and do not incorporate airspace and other airfield operational factors that may also influence capacity.

(1) Operational capacity of configuration in operations per hour when operated to achieve a balance of arrivals and departures (50% arrivals/50% departures). Estimates were developed using FAA's Capacity and Delay Model.

(2) Operational capacity of configuration in operations per hour when operated to achieve a balance of arrivals and departures (50% arrivals/50% departures). No estimate provided for quadruple independent IFR arrival operations. Estimates based on FAA's air traffic control tower methodologies.

(3) Capacity of "East" flow IFR configuration using triple approaches to parallel 9's to maximize arrival capacity.

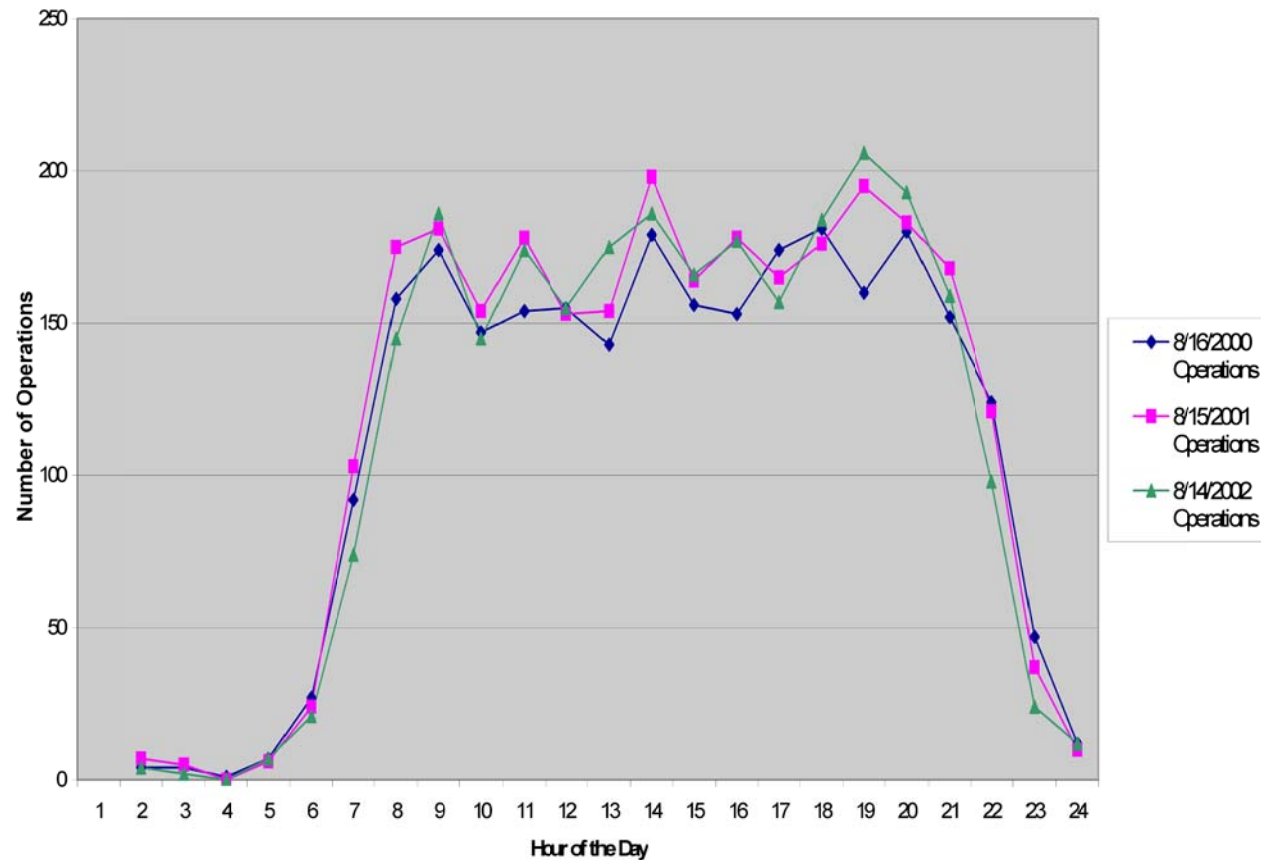
Nonetheless, as discussed later, these configurations can and do provide significant arrival delay reduction benefit during those conditions where the triple IFR arrival stream is needed and useful.

6. For purposes of the discussions that follow, the capacity estimates derived using the FAA's Capacity and Delay model techniques are used here. These estimates are used because they provide the more conservative difference in capacity gain between the two options, i.e., the smallest difference.

III. AIRCRAFT OPERATIONAL LEVELS

1. Following the tragic events of September 11, 2001, aircraft operational levels dropped significantly at airports throughout the country. At O'Hare, aircraft activity associated with commercial scheduled service changed both in terms of volume of operations and in terms of the distribution of those operations throughout the day. There have also been changes in the mix of aircraft used to provide the service. Despite significant changes, however, scheduled passenger aircraft operations at the Airport are expected to reach levels similar to those experienced in August 2001 by this August.
2. A review of schedule information contained in the Official Airline Guide indicates that there are currently 2,650 passenger operations scheduled for the third Wednesday of August 2002 at O'Hare compared to 2,735 passenger operations scheduled for the third Wednesday of August 2001. **Exhibit 2** shows a graphical comparison of the scheduled passenger operations by hour for these two days in August of 2001 and 2002. Exhibit 2 also includes the third Wednesday of August 2000 for comparison purposes. It should be noted that August has traditionally been the peak month of activity at O'Hare (historically, August and July have alternated as the peak month of activity) and a Wednesday is usually selected to represent an average day, thus providing, in this case, a surrogate for the Peak Month/Average Day (PMAD) in airport planning.
3. **Exhibits A1** through **A6** in the appendix to this discussion outline provide further comparisons of the schedule changes affected by the hubbing airlines at O'Hare between August 2001 and August 2002. These exhibits illustrate changes made to arrival, departure, and operations patterns by these carriers. **Exhibit A7** and **Exhibit A8** illustrate the arrival and departure patterns for all scheduled passenger service at the Airport.
4. Exhibit 2 illustrates the fact that scheduled passenger operations (not including non-scheduled service, cargo, general aviation/corporate, military, and other which collectively account for approximately five percent of the operations) during most of the daytime operating hours of August 2002 can be expected to match or exceed those experienced in August 2001. The approximately three percent difference in total daily operations between the two schedules appear to consist mostly of activity in the shoulder and nighttime hours. The number of operations scheduled for the peak hour in August 2002 is actually higher than what was scheduled for August 2001. A similar set of patterns is apparent when arrivals and departures are viewed separately, though the timing of the peaks is different. A review of the schedules using more finite time intervals (i.e., rolling 10-minute intervals) produces similar conclusions.

August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 2

All Carriers Operations August 2000, 2001, and August 2002

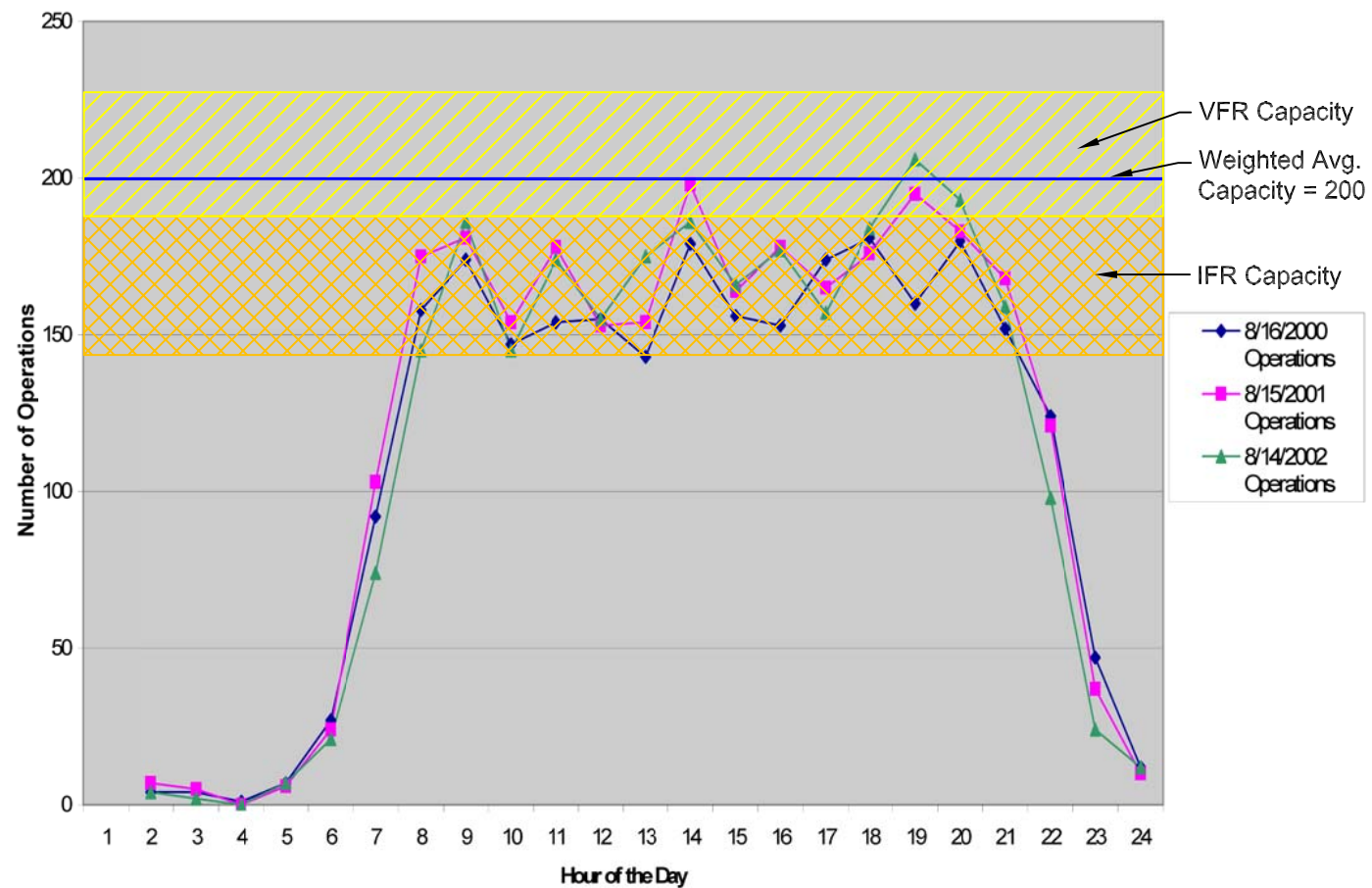
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5. In general, the levels and distribution of scheduled aircraft activity projected for August 2002 can be expected to impose similar operational demands on O'Hare's airfield as those imposed by the activity scheduled in August 2001. Fleet differences, in addition to weather and the impacts of other components of activity, may exacerbate those impacts.
6. While it is difficult to predict with certainty what the future patterns of activity will look like and the rate at which activity will grow, the last three years do provide a range of patterns of activity that can be used to assess the relationship between aircraft operational demand and capacity and delay at O'Hare.

IV. CAPACITY/DEMAND RELATIONSHIP

1. For comparison purposes, **Exhibits 3, 4, and 5** show the relationship between the activity distributions of scheduled passenger operations for August 2000, 2001, and 2002 and the IFR and VFR capacity ranges for the existing airfield and the two runway phasing alternatives being discussed. These exhibits also show the weighed average capacity for each runway phasing option. In each exhibit, the ranges in the IFR and VFR capacity depict the difference between the “best” and “worst” performing operating configurations.
2. Delay levels experienced during the summer of 2000 and 2001, excluding the effects of labor actions on delay levels in 2000, suggest the Airport operated at the threshold of VFR capacity during that period of time. Similarly, the level of weather-related delays during that period of time also suggest the Airport generally performed poorly during IFR conditions. Both of these generalizations are consistent with Exhibit 3. In general, Exhibit 3 shows that activity at the Airport during August of 2000 and 2001 generally exceeded the IFR capacity of the airfield during the operating hours of the day and was just below the weighed average hourly capacity for the Airport. With a slightly more pronounced peaking of activity, the August 2002 schedule of activity can be expected to impose similar or greater operational pressure on the airfield depending on fleet mix distributions and the interactions with non-scheduled activity.
3. Exhibits 4 and 5 show similar information for the north runway only phasing alternative and the phasing alternative with both the north runway and the closely-spaced south runway. As Table 1 shows, the two-runway alternative provides a greater increase in VFR capacity and balanced IFR capacity with the resultant increase in the weighed average capacity for that alternative. Thus, the capacities of the VFR operating configurations (both the high and the low) for the two-runway alternative are clearly above the operating levels experienced even during the peak periods.
4. **Exhibit 6** shows the 2001 FAA’s Terminal Area Forecasts (TAF’s) for Chicago O’Hare International Airport. These forecasts have been adjusted to reflect calendar years instead of fiscal years, but otherwise remain as published by the Federal Aviation Administration. The TAF’s are used here for reference purposes to assist in framing the discussion regarding demand levels. It is important to note that the TAF’s used here are those published by the FAA in 2001. A new release of the TAF’s should be available in the upcoming months and may reflect higher or lower projections for O’Hare, as those forecasts are adjusted to reflect both the effects of the elimination of the High Density Rule and airline adjustment to a more open market at the Airport as well as the recent general economic slowdown, the impacts of the September 11, 2001 terrorist attacks, and other factors.

August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



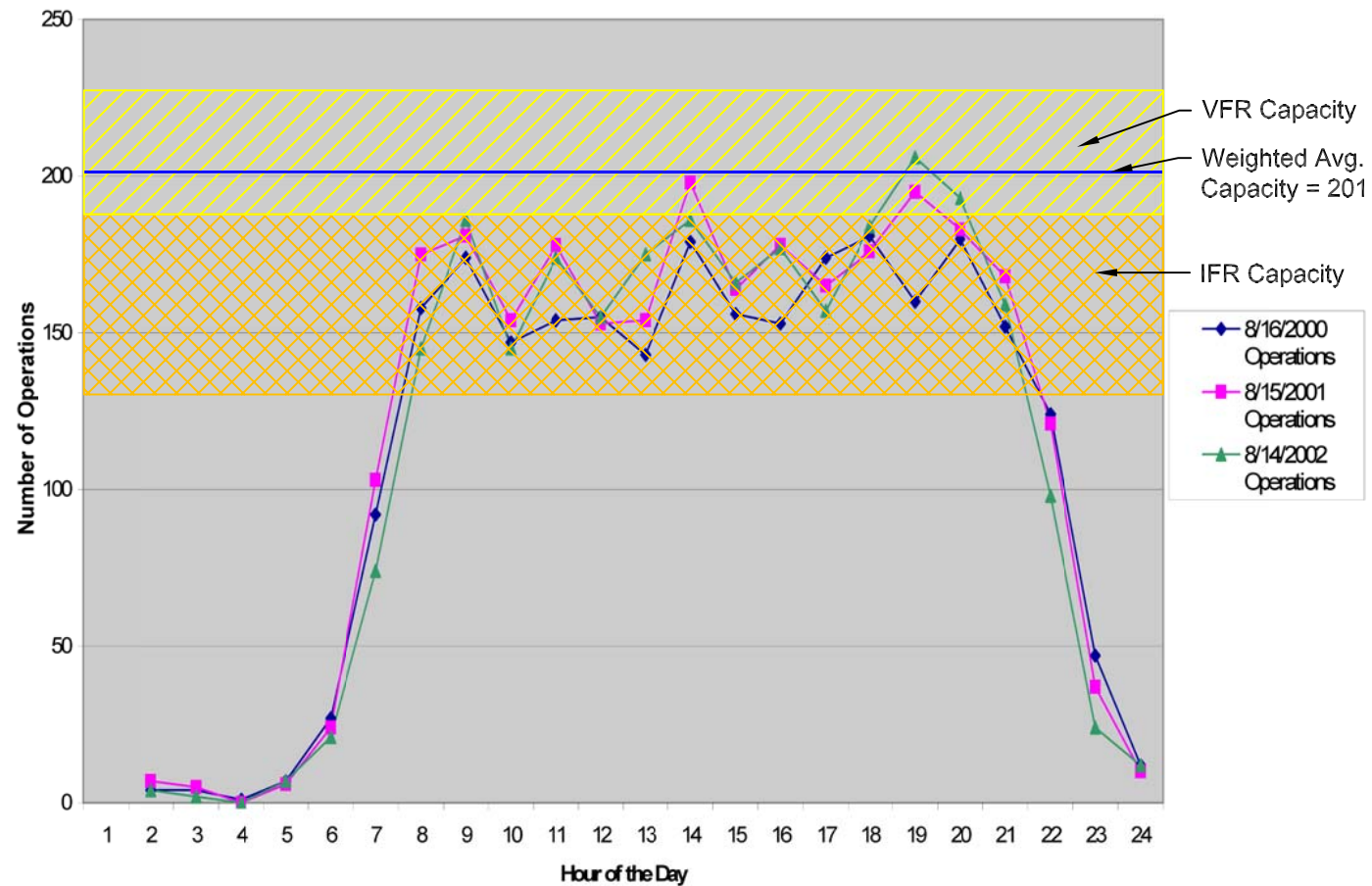
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 3

Capacity/Demand Existing Airfield

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August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



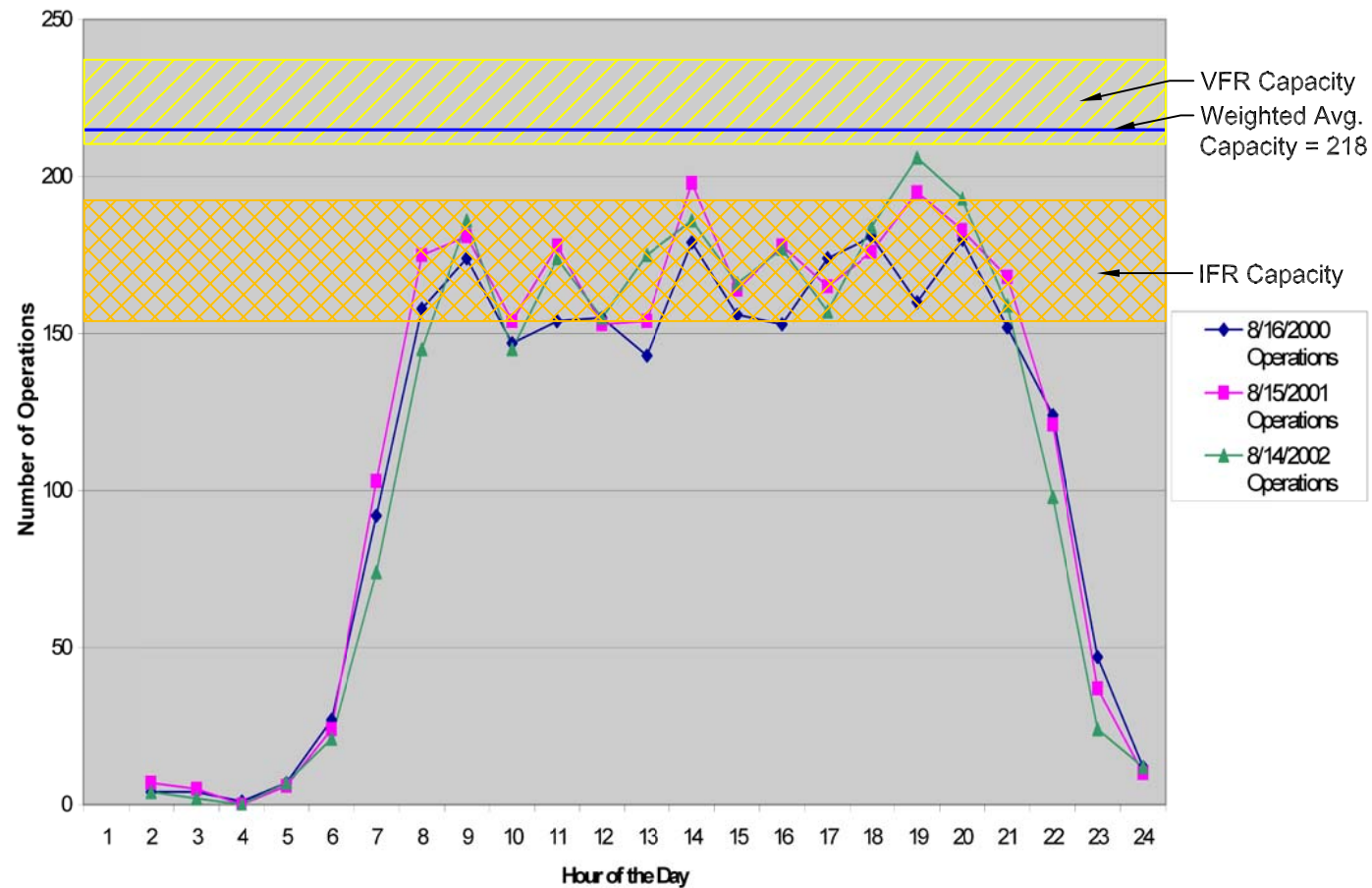
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 4

Capacity/Demand Existing Airfield Plus North Runway

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August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



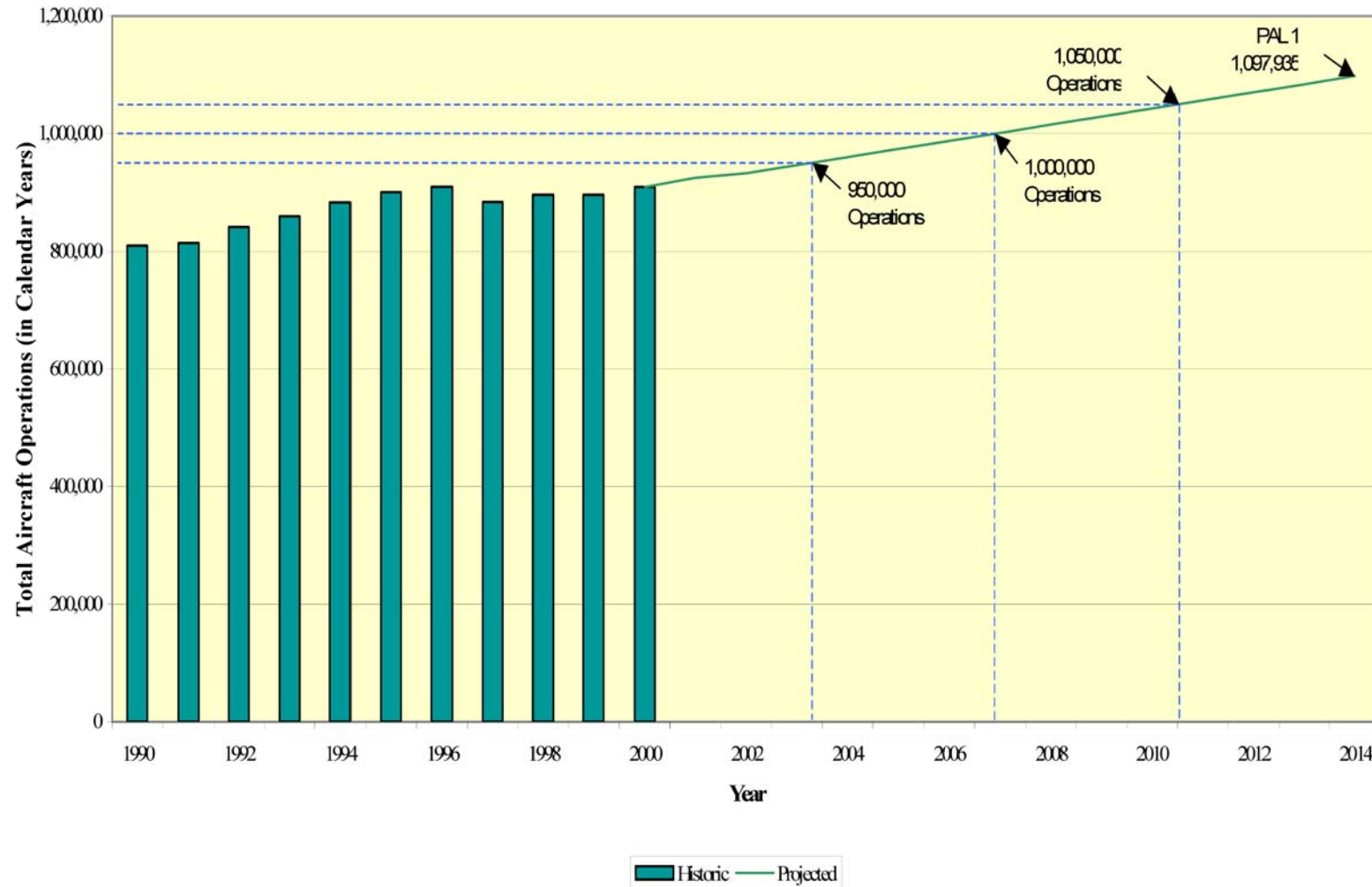
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 5

Capacity/Demand

Existing Airfield Plus North Runway and Closely Spaced South Runway

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Source: 2001 FAA Terminal Area Forecasts; Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

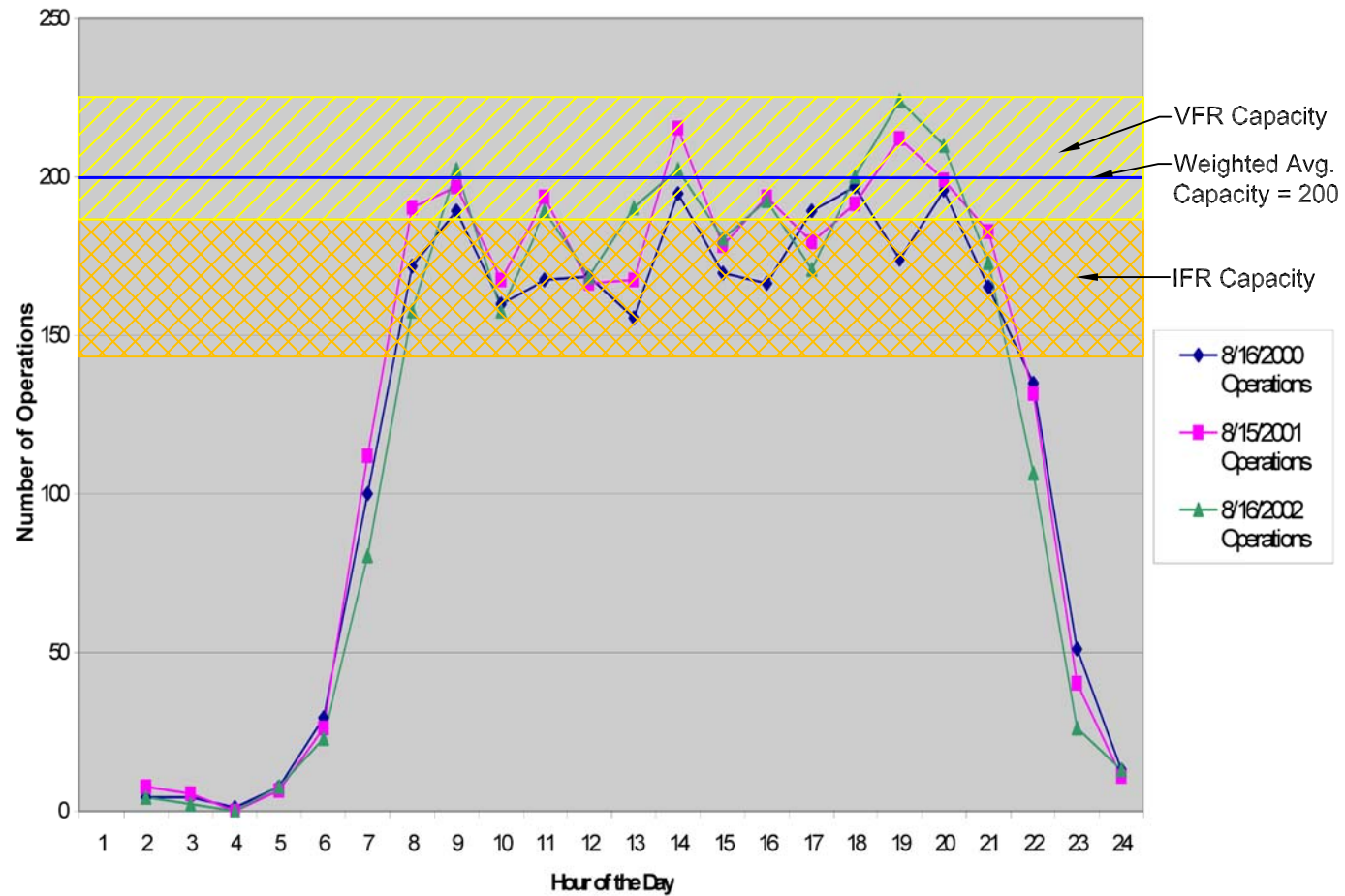
Exhibit 6

2001 FAA Terminal Area Forecasts Total Aircraft Operations in Calendar Years

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5. Assuming earliest construction of the initial runway to be 2006, an operational level of approximately one million operations could be estimated for that period or beyond at the earliest operational date for a runway. It is anticipated that the closely-spaced runway could be built by 2008, to correspond to an operations level of approximately 1,025,000 movements. For comparison purposes, Department of Aviation records show that approximately 911,800 operations were handled at the Airport in 2001. Also for comparison purposes, **Exhibits 7, 8, and 9** show the relationships between the capacity ranges and weighed averages for the runway phasing options discussed and a demand level of one million total annual operations assuming demand profiles similar to those experienced in the years 2000 and 2001 and projected for 2002. Similar to other exhibits in this discussion outline, Exhibits 7, 8, and 9 show only scheduled passenger operations.
6. **Table 2** shows a comparison of the delay savings and associated cost savings that would be expected at various demand levels should either runway alternative be available at that point. For this analysis, runway capacities and associated delay estimates were computed using the FAA's Capacity and Delay model, and annualized demand profiles from calendar year 2000 (the last full year of operations prior to the September 11, 2001 attacks). As shown in Table 2, both runway alternatives provide significant delay savings by virtue of the increased arrival capacity they provide in IFR conditions, thus helping relieve the arrival delay problem that significantly affects the Airport during those conditions. The alternative with both the north and the closely-spaced south runway, however, provides not only improved performance during IFR conditions, but also increased capacity during VFR conditions. In addition, during IFR conditions, the two runway option provides increased departure capacity. It is significant to note that given the nature of the FAA's capacity and delay model, departure delays resulting from the Airfield's inability to match its arrival capacity are not captured. Therefore, delays associated with the single runway scenario are likely underestimated in Table 2. Similarly, the difference in delay savings between the two scenarios are lower than would be expected if these delays were captured. **Exhibit 10** shows cumulative incremental delay savings of the two runways compared to the single runway scenario.
7. Table 2 does not reflect, however, the increased scheduling opportunities and operational reliability offered by the increased VFR capacity. The approximately 10 percent increase in overall weighed average VFR/IFR capacity represents a significant gain in capacity that will be available most of the time to support airport operations (as opposed to just IFR arrival operations).

August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



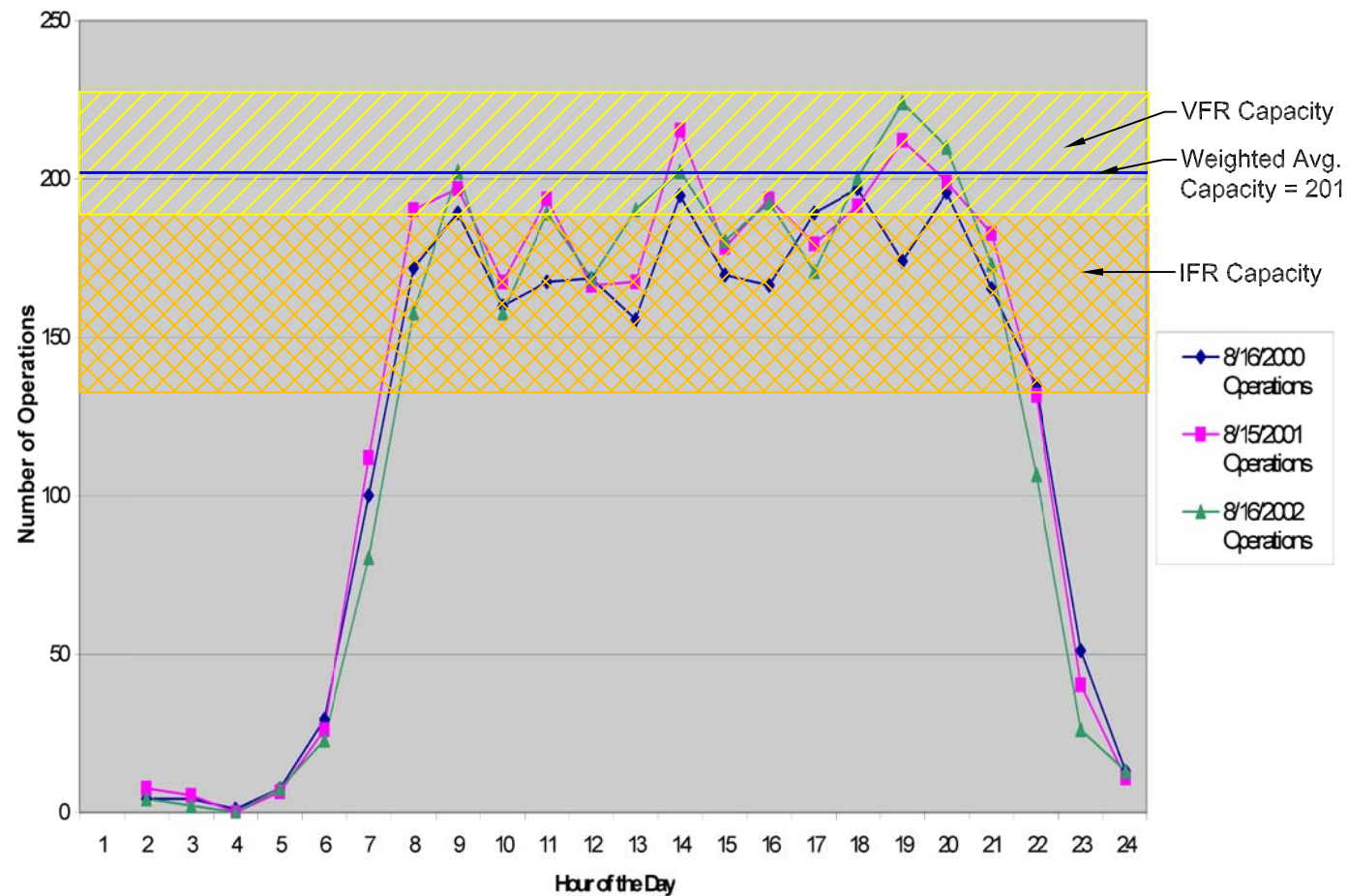
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 7

Capacity/Demand-1,000,000 Annual Operations Existing Airfield

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August 2000, 2001, and 2002- All Carriers-ORD Operations, by hour



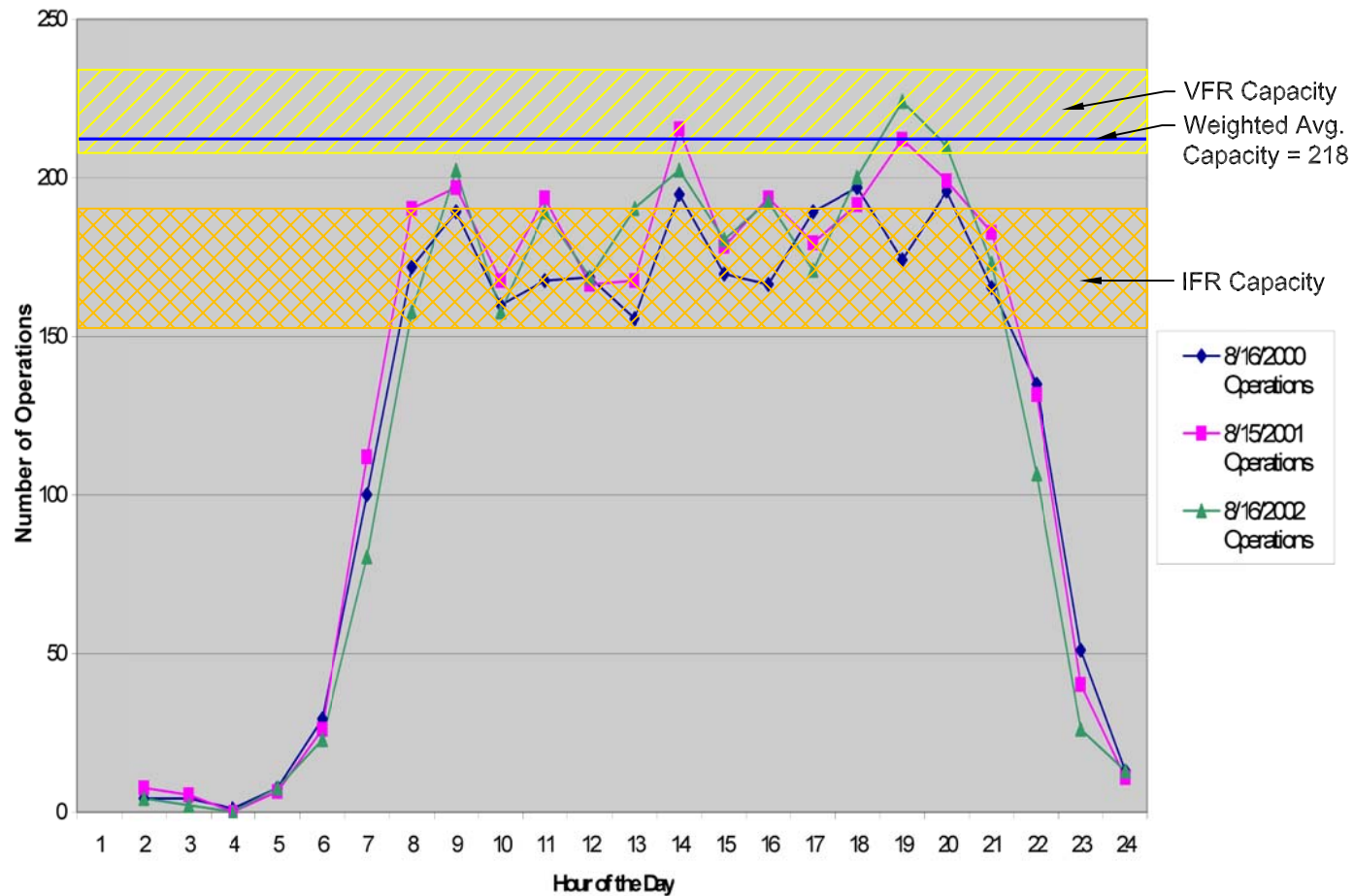
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 8

Capacity/Demand-1,000,000 Annual Operations Existing Airfield Plus North Runway

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August 2000, 2001, and 2002- All Carriers-CRD Operations, by hour



Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit 9

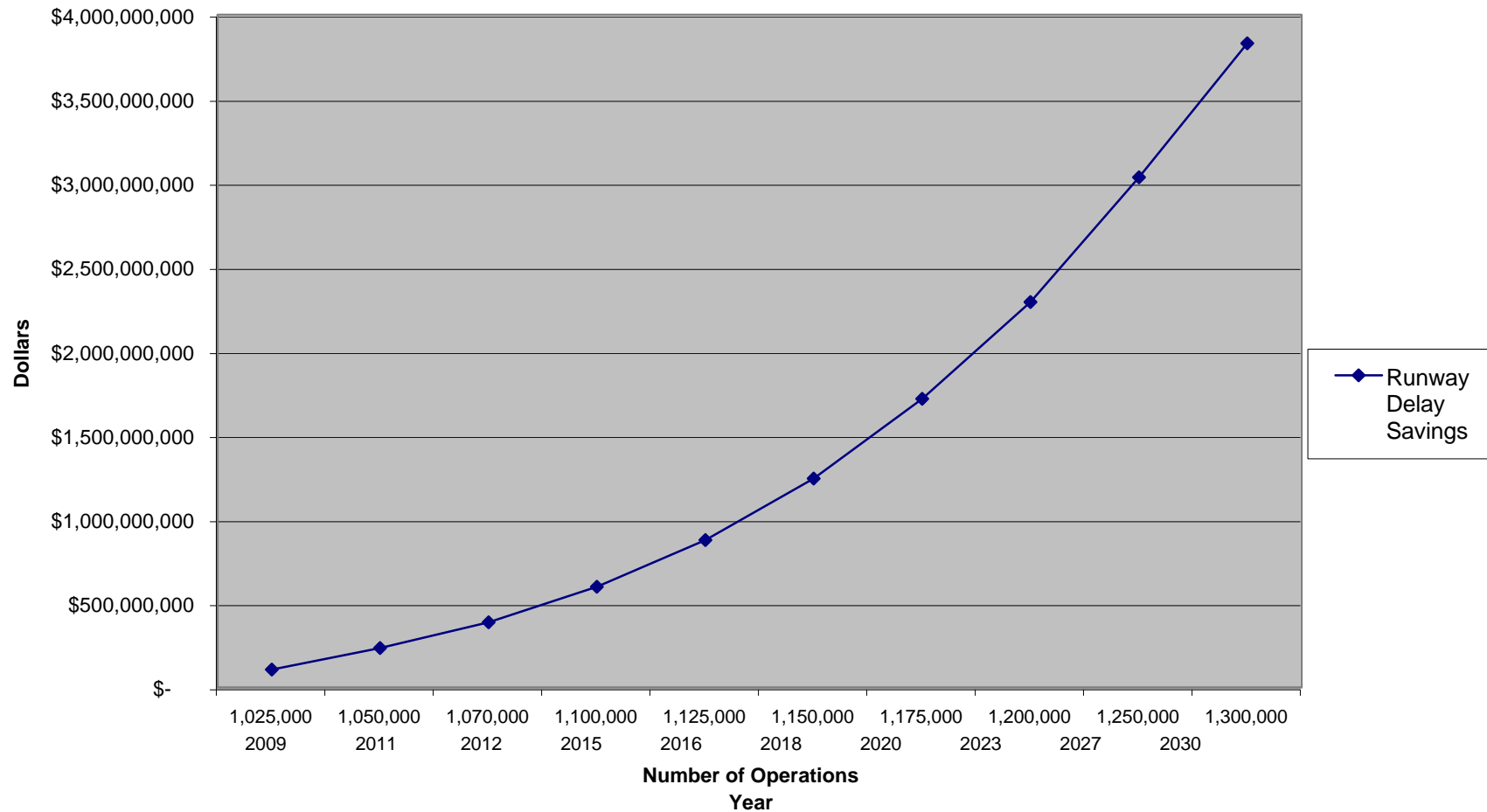
Capacity/Demand-1,000,000 Annual Operations Existing Airfield Plus North Runway and Closely Spaced South Runway

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ANNUAL OPERATIONS LEVEL													
Operations: Year:	909,000 2002	950,000 2004	1,000,000 2007	1,025,000 2011	1,050,000 2013	1,070,000 2014	1,100,000 2016	1,125,000 2018	1,150,000 2020	1,175,000 2021	1,200,000 2022	1,250,000 2025	1,300,000 2028
ANNUAL DELAY COSTS													
Existing Airfield	\$45,122,760	\$73,967,000	\$107,440,000	\$126,854,000	\$152,439,000	\$180,808,600	\$246,092,000	\$324,360,000	\$428,927,000	\$558,501,000	\$707,064,000	\$1,017,875,000	\$1,323,790,000
Existing Airfield plus North Runway and Closely- Spaced South Runway	\$14,525,820	\$19,703,000	\$34,000,000	\$20,213,000	\$23,919,000	\$27,648,800	\$35,904,000	\$45,900,000	\$62,951,000	\$85,493,000	\$130,560,000	\$277,100,000	\$525,980,000
ANNUAL DELAY COST SAVINGS													
Existing Airfield plus North Runway and Closely- Spaced South Runway	\$30,596,940	\$54,264,000	\$73,440,000	\$106,641,000	\$128,520,000	\$153,159,800	\$210,188,000	\$278,460,000	\$365,976,000	\$473,008,000	\$576,504,000	\$740,775,000	\$797,810,000
CUMULATIVE COST SAVINGS													
Existing Airfield plus North Runway and Closely- Spaced South Runway	N/A	N/A	N/A	\$106,641,000	\$235,161,000	\$388,320,800	\$598,508,800	\$876,968,800	\$1,242,944,800	\$1,715,952,800	\$2,292,456,800	\$3,033,231,800	\$3,831,041,800

NOTES:
- Delay costs estimated on the basis of \$34 per minute of delay. O'Hare Delay Task Force, June, 2002.

Cumulative Runway Delay Savings



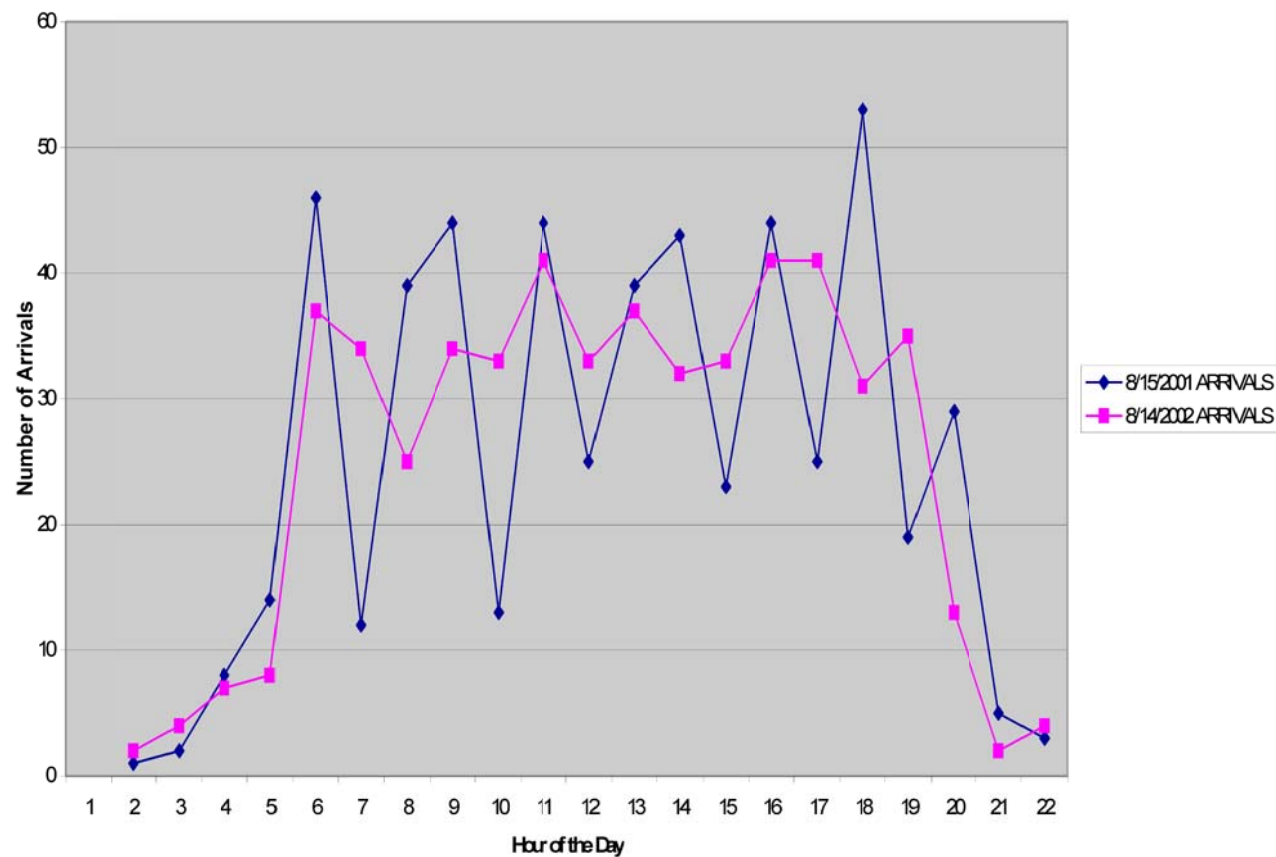
Source: Ricondo & Associates
Prepared by: Ricondo & Associates

**Cumulative Cost Saving- Existing Airfield plus North Runway
and Closely-Spaced South Runway**

September 25, 2002

APPENDIX

August 2001 vs. August 2002 American Airlines Arrivals, by hour



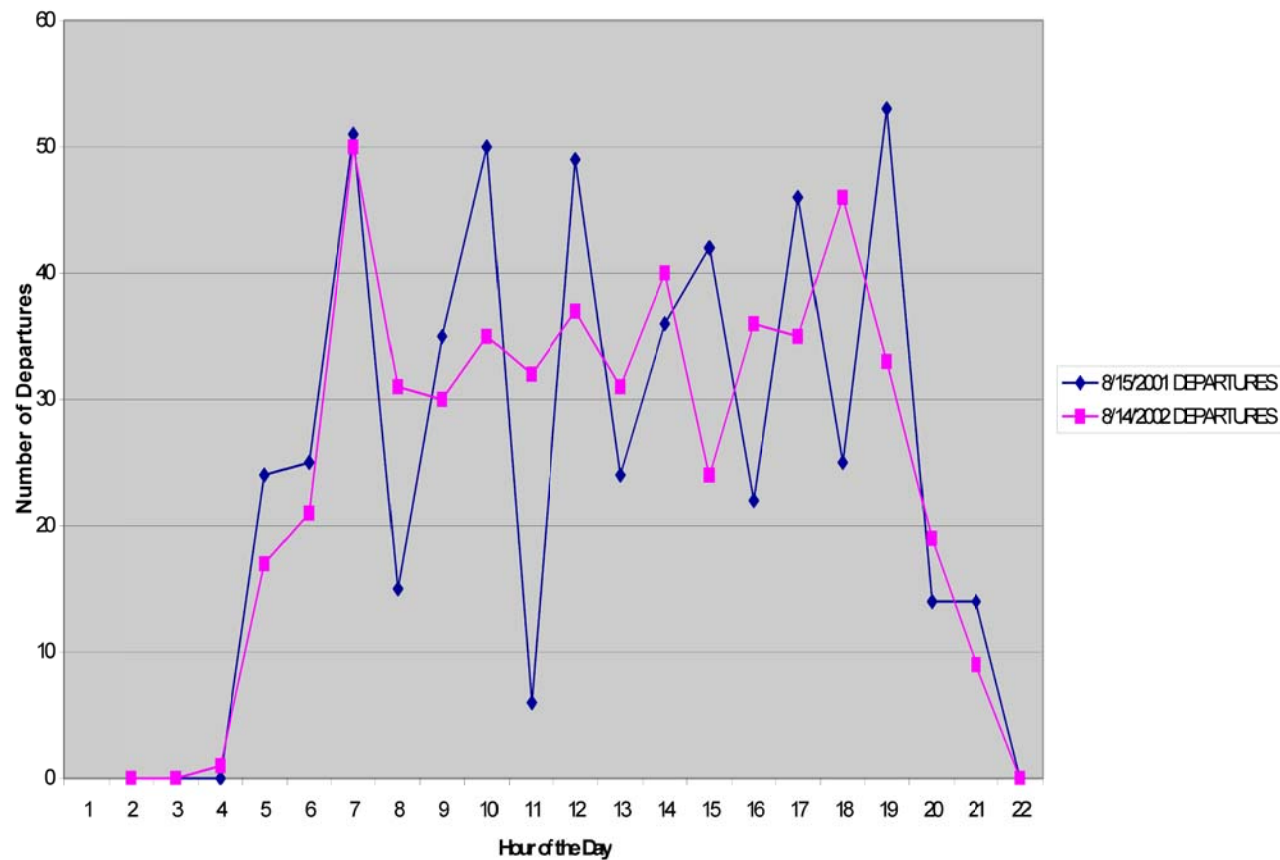
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A1

American Airlines Arrivals August 2001 vs. August 2002

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August 2001 vs. August 2002 American Airlines Departures, by hour



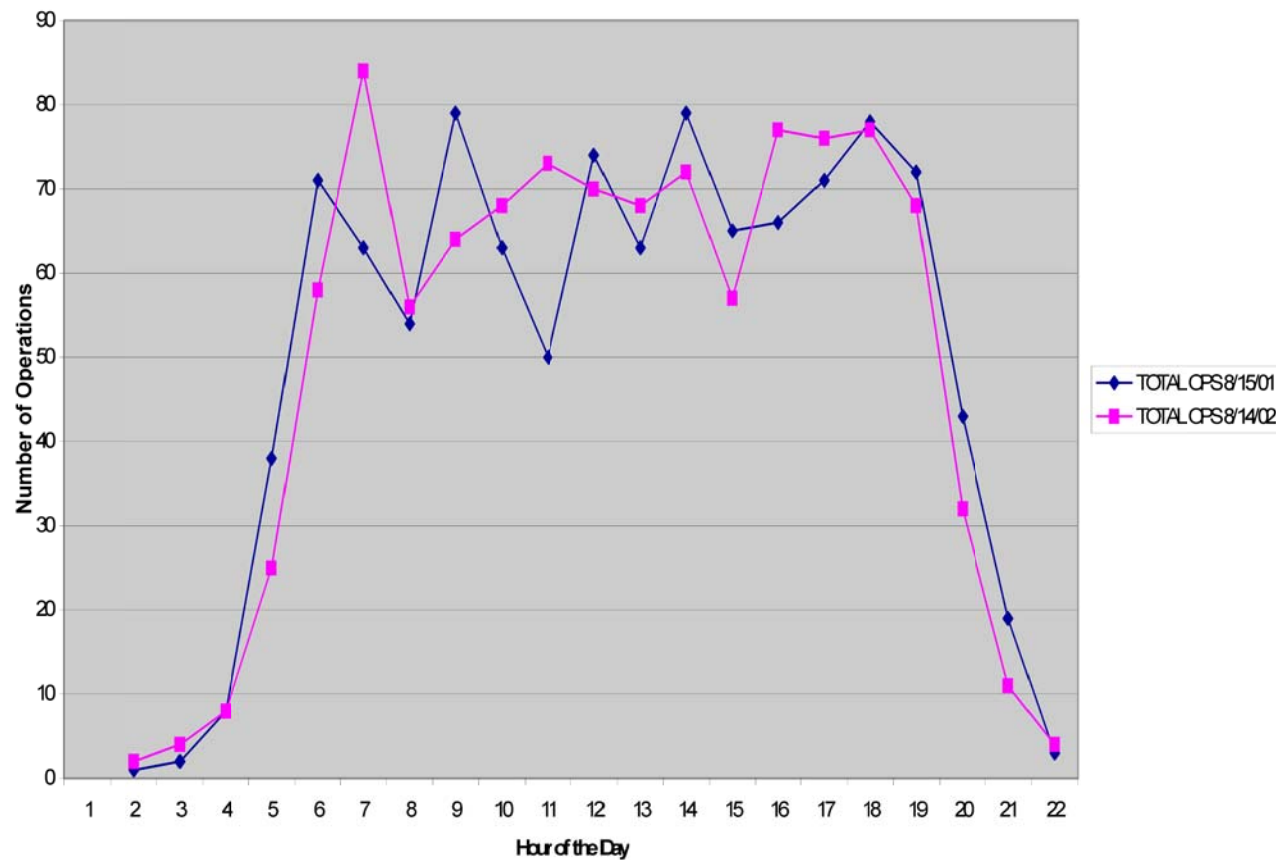
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A2

American Airlines Departures August 2001 vs. August 2002

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August 2001 vs. August 2002 American Airlines Operations, by hour



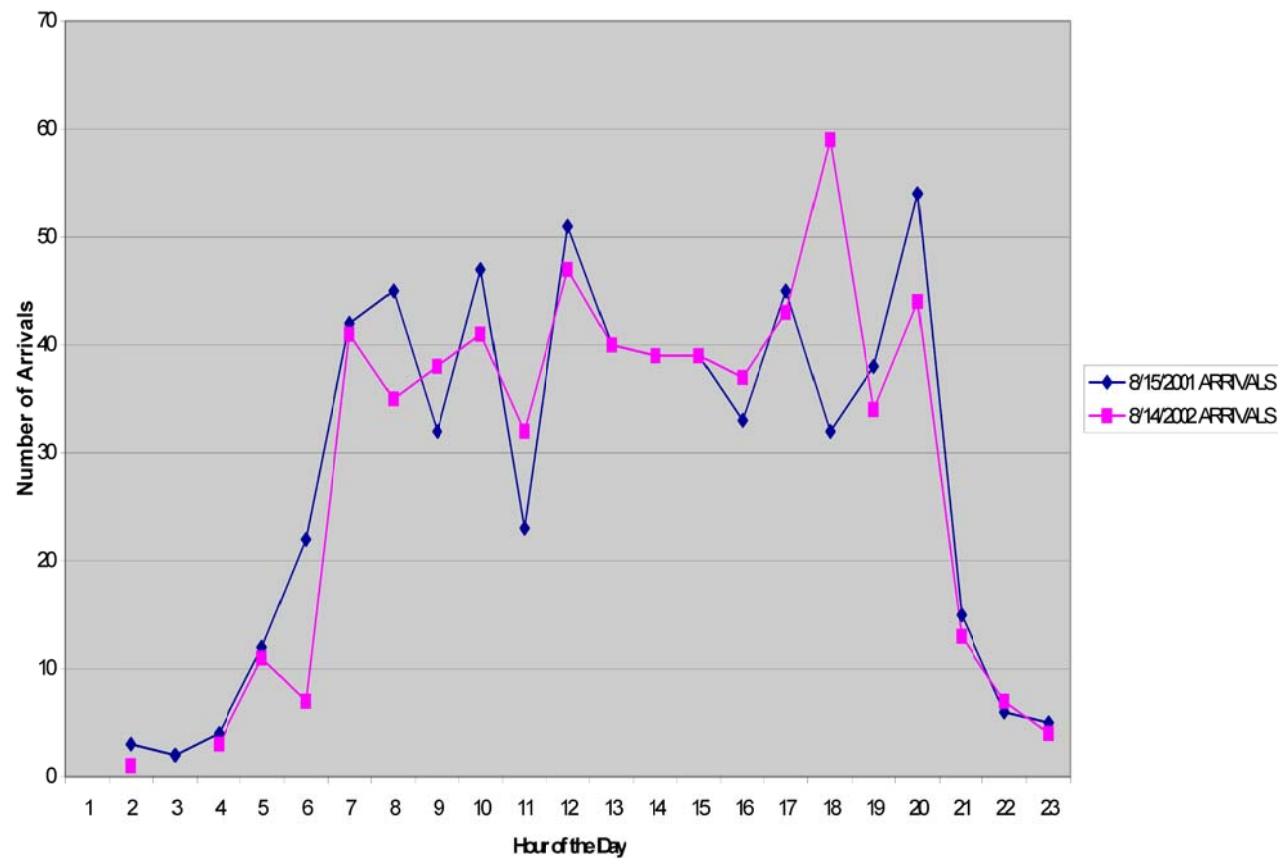
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A3

American Airlines Operations August 2001 vs. August 2002

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August 2001 vs. August 2002 United Airlines Arrivals, by hour



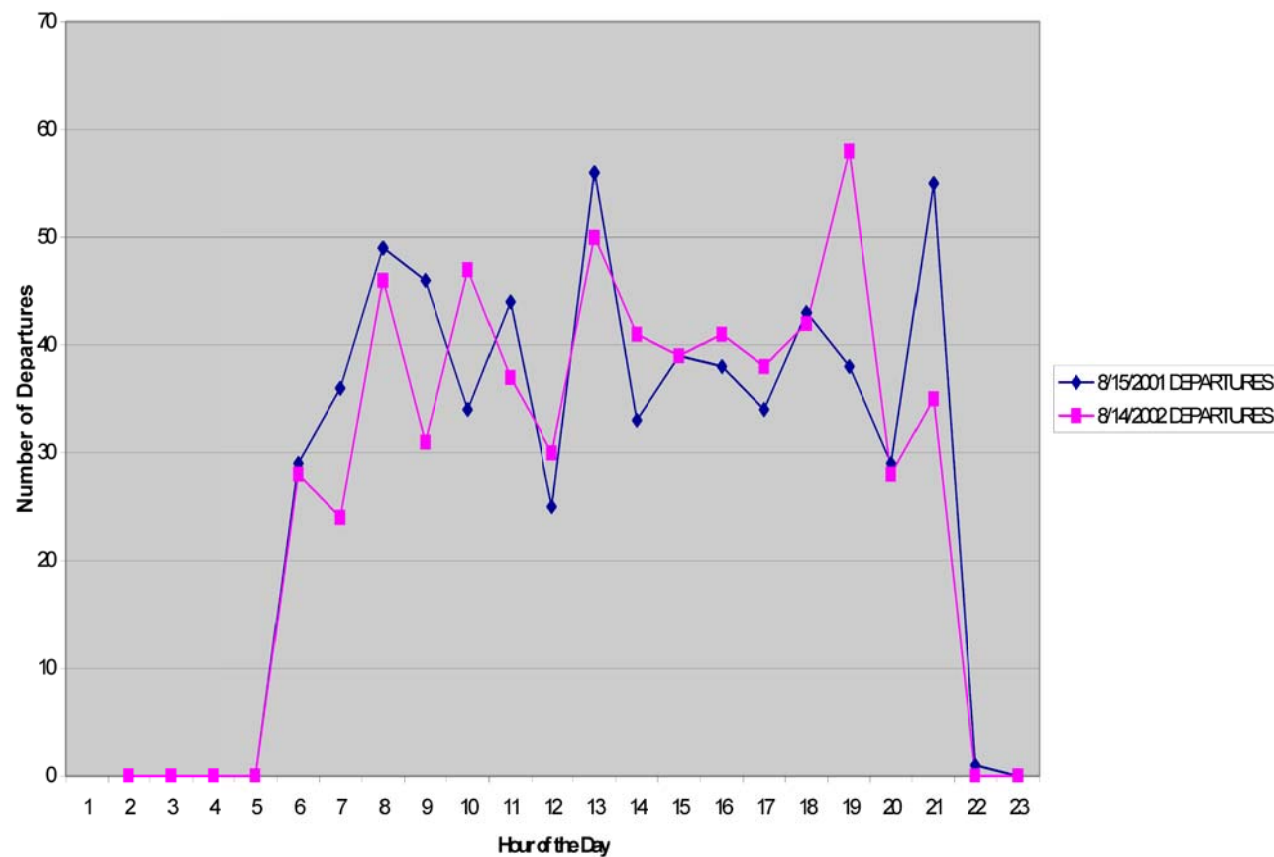
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A4

United Airlines Arrivals August 2001 vs. August 2002

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August 2001 vs. August 2002 United Airlines Departures, by hour



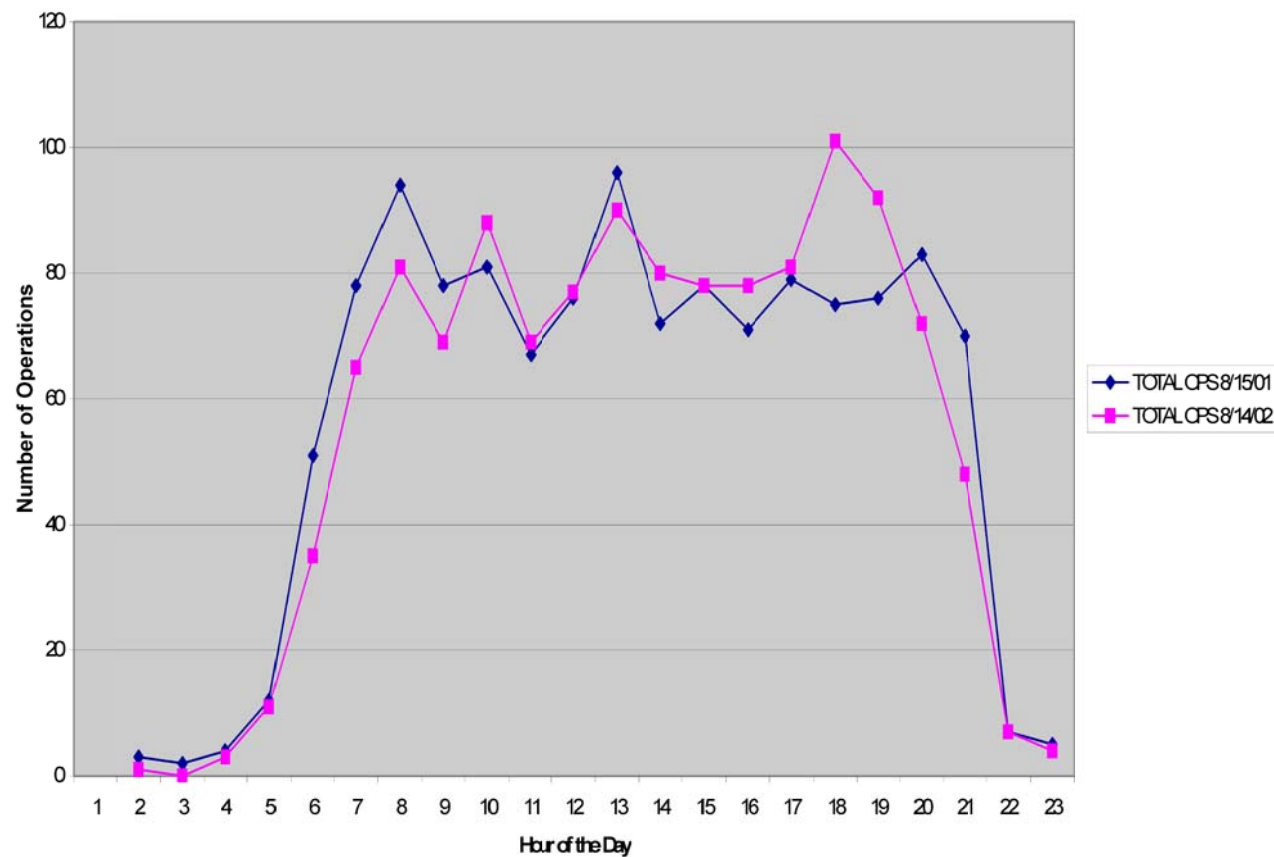
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A5

United Airlines Departures August 2001 vs. August 2002

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August 2001 vs. August 2002 United Airlines Operations, by hour



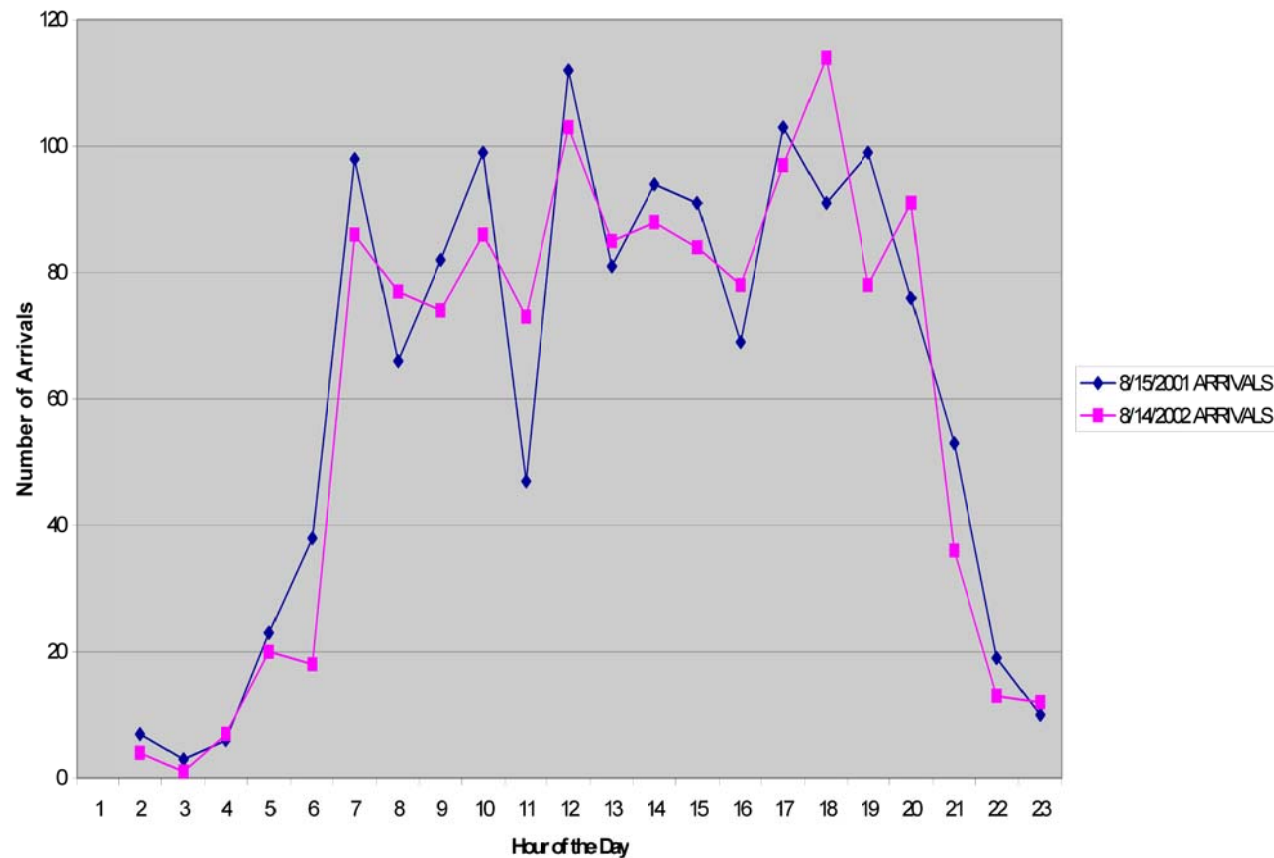
Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A6

United Airlines Operations August 2001 vs. August 2002

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August 2001 vs. August 2002 All Carriers-ORD Arrivals, by hour

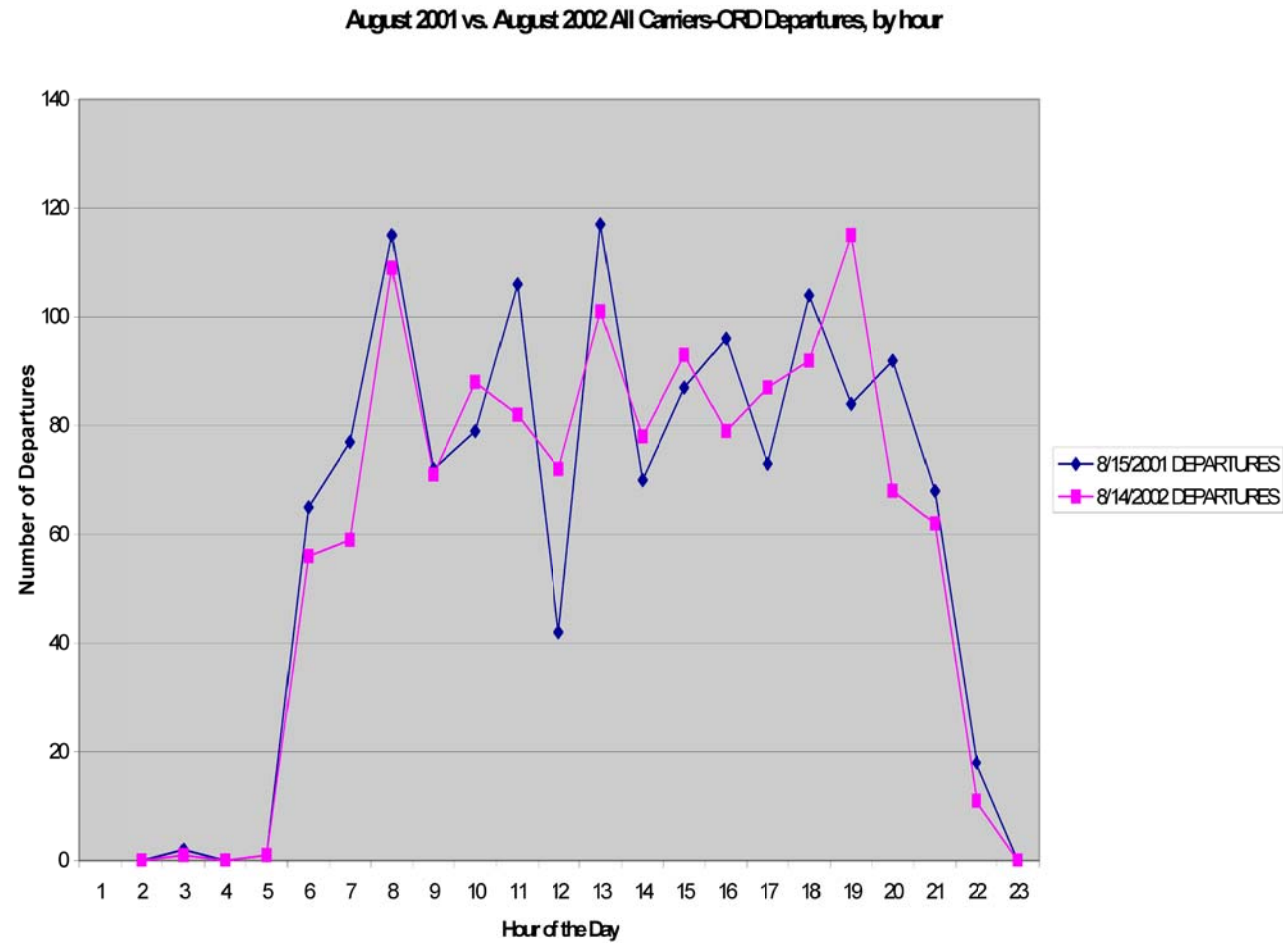


Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A7

All Carriers Arrivals August 2001 vs. August 2002

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Source: Official Airline Guide, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit A8

All Carriers Departures August 2001 vs. August 2002

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